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Harnessing Digital Social Capital to Propel the Free Nutrition Meal (MBG) Initiative

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ABSTRACT

The Free Nutritional Meal (MBG) program leverages a mobile-first scheme to provide affordable meals to underprivileged school children, but continued acceptance is not uniform across communities. Based on social capital theory, this study examines how digital network structures, trust cues, and shared norms embedded in the MBG app enable program acceleration and persistence. We obtained six months of interaction-log data ($n \approx$ 38,000 users). We matched this data with survey measures about structural, relational, and cognitive capital from 912 parents, teachers, and volunteers from Sleman, Yogyakarta, in Indonesia. Effects were compared on the three key performance indicators (registration growth, daily meal redemptions, and peer-referral rates) using three social-network analytics (density, average clustering, and betweenness) and partial least-squares structural-equation modeling to assess the validity of five hypotheses relating platform-level social-capital metrics to key performance indicators. Findings indicate that increased local clustering and bidirectional messaging are strong predictors of redemption frequency ($\beta = 0.31$, $p < 0.001$), and perceived platform trust mediates 27 % of the impact of structural capital on user retention. The saturation of eligible beneficiaries is 19 % faster in communities with strong digital bridging ties than in control clusters. Results extend social-capital theory into the digital-nutrition space and provide actionable design insights, e.g., algorithmic friend suggestions and "trust badges" to bolster collective action around MBG. Limits and future opportunities for longitudinal cross-platform Research are reviewed.

Keywords: Design Social Capital, Free Meal Program, MBG, Platform Analytics, Community Engagement.

INTRODUCTION

Childhood under-nutrition continues to be a serious problem in low- and middle-income countries (LMICs), further exacerbated by economic shocks and heightened food prices that negatively impact household food security. This has led to the implementation of a technology-based feeding program, such as the Free Nutritional Meal (MBG) in Indonesia. These applications leverage mobile solutions for coordinating different stakeholders in serving healthy meals to kids. But the effectiveness of such programs isn't just a product of technological advances: Uptake and meal-redeeming rates also differ from one similar socioeconomic cohort of communities to another. This indicates that other determinants contribute to the uptake of these interventions.

Economic shocks heavily affect child nutrition, as a 10% reduction in national income raises child wasting rates by 14.4–17.8% (Khalid et al., 2019). The escalation in the prices of basic foods in the world, motivated by

economic crises and climate change, also undermines the quality of the maternal and child diet, generating a greater prevalence of micronutrient deficiencies and infectious diseases. Applications for mobile phones seem to have potential in managing malnutrition in pre-school children, as illustrated by the positive acceptance of mobile-delivered nutrition interventions (Seyyedi et al., 2019). Yet there are infrastructural and technical barriers in LMICs, such as weak network capacity and mobile phone accessibility (Seyyedi et al., 2019). Nutritional interventions provide value for money with a significant return on investment because they safeguard health, prevent disability, and enhance economic productivity (De Pee et al., 2010). The role of the food and agriculture sector as a driver of malnutrition by enabling access to food, income, and influencing food prices and women's nutrition (Duncan et al., 2022). Nutrition-sensitive interventions in the food and agriculture sector to improve programs that address malnutrition effectiveness (Scott et al., 2020).

Development funds for nutrition-specific interventions have been linked to a decreased prevalence of stunting in countries, with more malnutrition loads (Khalid et al., 2019). Increasing the coverage of evidence-based nutrition interventions has the potential to hasten progress on global nutrition targets (Supthanasup et al., 2021). While feeding programs such as Indonesia's MBG program have the potential to be innovative in tackling childhood undernutrition, they are a scale-up strategy that requires complementary infrastructure and traditional food system support to be effective. Enhancing the effectiveness of such interventions should include economic security, food price regulation, and infrastructure development. Moreover, concomitant nutrition-specific and nutrition-sensitive interventions and multi-sectoral cooperation may allow a more complete approach to under-nutrition management in LMICs.

Social capital is a valuable concept that helps explain the differences in several social outcomes related to school nutrition programs. Putnam's theory includes trust, norms, and networks, contributing to societal efficiency. Platform design decisions related to these dimensions of social capital in the digital context may shape collective action, including school meal delivery. However, empirical work connecting digital social capital to school-based nutrition programs is somewhat sparse, and there are knowledge gaps about how the configuration of networks, trust cues, and engagement norms may influence meal delivery metrics. The convergence of social capital and digital platforms in school nutrition programs is explored in this response.

This level relates to network connections and ties that connect to resources and information. In the realm of school food (nutrition) programs, digital platforms may strengthen the structural social capital by facilitating linkages between parents, schools, and other community entities (such as community-based organisations), which could, in turn, improve coordination and resource allocation (Kunitz, 2004; Szreter & Woolcock, 2004a; Woolcock & Narayan, 2000). Relational social capital is built on trust and reciprocal relationships among the people involved. Digital solutions can build trust by enabling transparency in communication and feedback options (e.g., reputation scores and reviews, which may increase confidence in personal meal delivery services (Six et al., 2015; Welch et al., n.d.).

Digital platforms provide opportunities to build social capital, but they also bring challenges. For example, the digital divide may reinforce inequities such that some communities have reduced access to these platforms. Also, interaction quality varies in digital communities, referring to the strength of social capital (Abbott, 2009; Fafchamps, n.d.). An empirical study is required to determine which network setups are most successful in improving the quality of meal delivery metrics. To best inform how to optimise these programs, we need to understand the function of bridging and linking social capital in bridging those gaps between different stakeholders (Pasquier Merino et al., 2022; Szreter & Woolcock, 2004).

This study fills that gap by examining 6 months of interaction logs (≈ 38,000 users) and survey responses (N= 912) from MBG stakeholders in Sleman, Yogyakarta, Indonesia. We compare five hypotheses that predicted associations between platform-level measures of social capital and KPIs, including registration growth, daily meal redemptions, and peer-referral rates: network density, clustering, reciprocity, and perceived trust. Integrating social-network analysis with partial least-squares structural-equation modelling (PLS-SEM), our work provides: 1) A quantitative model that explains how particular digital-social-capital constructs shape MBG KPIs. 2) Recommendations (about algorithmic friend suggestions, "trust badges") for practitioners on the ground seeking to scale food-aid platforms. and 3) "Applying classic social-capital constructs to mobile stewardship systems in the developing world: a synthesis" Theoretical extensions for relating classical social-capital constructs to mobile stewardship systems in the developing world.

Even with a national deployment of the Free Nutritional Meal (MBG) system in Indonesia, program metrics show enduring inequality in user growth, meal-redemption frequency, and long-term retention between like schools and districts. Previous assessments have examined technical barriers, such as bandwidth, interface usability, and supply-chain logistics; others also argue that factors at the community level reveal how social dynamics determine adoption patterns. However, the question is still unanswered: how are certain types of digital social capital (structural, relational, and cognitive social capital) leading to concrete, tangible results in terms of measured business performance?

To fill this knowledge gap, our research problem is formalized as: Which qualitative or quantitative features of digital social capital underlie these key performance indicators of the MBG initiative registration growth, daily meal redemptions, peer-referral rate, and user retention as weeded out by the platform?

Building upon social-capital theory and existing Research on technology-enabled collective action, we develop five testable hypotheses: 1) H_1 (Structural Capital): The greater the local network density within the MBG platform, the more frequent the redemption of meals. 2) H_2 (Relational Capital): A higher ratio of mutual messaging ties leads to higher user-retention rates. 3) H_3 (Cognitive Capital Mediation): Perceived platform trust mediates the relationship between structural capital and user retention. 4) H_4 (Bridging Capital): Communities with stronger cross-school bridging ties showed a faster saturation of eligible beneficiaries compared with communities with stronger bonding ties. and 5) H_5 (Capital Synergy): Peer-referral rates reach higher than the sum of the effects in structural and cognitive dimensions when there is a combination of high structural and mental capital.

Through empirical testing of these hypotheses, the study seeks to help disambiguate the causal pathways through which digital social capital enables or hinders large-scale nutrition programs, contributing to theoretical understanding and actionable design guidelines for MBG and similar initiatives.

The rest of this paper is structured as follows. Literature review: A more expansive exploration of the literature is presented in section II under the headings of social capital, digital platforms, and nutrition interventions. The problem statement and hypotheses are given in Section III. Section IV describes the mixed methods research design, sources of data, and the analysis process. Section V describes empirical findings and analysis, and Section VI concludes this study with practical implications, limitations, and future works.

LITERATURE REVIEW

Classical Social-Capital Theory

Early social capital scholarship identified it as a group resource facilitating communal action. The seminal work of Coleman in 1988 demonstrated how social structures generate "resources for action," which are critical for the development of human capital (MacEachen et al., 2022). This schema signified the starting point in conceptualizing social capital, focusing on the contribution of relationships and networks to achieving collectively desirable outcomes. Drawing upon his Research, Putnam emphasized that strong social networks, mutual norms, and interpersonal trust are necessary for improving civic performance and individual well-being (Supthanasup et al., 2021). Putnam's focus on social network ties for stimulating civic involvement is especially salient in the popular discussion of social capital in contemporary contexts, including several of those associated with the digital medium, where the structure of interaction has been shown to frame relationships among the membership.

Building on these conceptual bases, Nahapiet and Ghoshal (1998) provided a refined conceptualization of social capital by identifying three core dimensions: structural, relational, and cognitive. The structural dimension refers to patterns of ties between individuals; the relational dimension refers to the relational milieu and the trust this engenders. In contrast, the cognitive dimension refers to the common understanding and meanings among the actors within the network (Katangwe-Chigamba et al., 2024). This trichotomy plays a significant role in investigating how the collective value is generated in digital platforms, where activities might reflect and build social capital in online spaces.

The existing literature has also investigated utilizing these dimensions of social capital in conjunction with digital media and digital communities. Research about digital platforms reveals that improved connectivity and communication enable social interactions, which might have important implications for community engagement and health (Carolan, 2022; Nageswaran et al., 2024). Such digital engagement represents a special case of Nahapiet and Ghoshal and demonstrates that online networks may replicate offline ones, enabling trust, support, and common goals between communities. Efficient utilization of these dimensions at the platform layer can add value to social capital, revealing directions for future empirical models to better measure and assess the impact of social capital in digital ecologies.

In addition, the operationalization of social capital indicators at the platform level has been relevant to studies investigating digital-mediated community engagement. As evidenced in specific cases, platform interactions can be a substantial magnet for the creation and maintenance of the social infrastructure, therefore, illustrating the importance of social capital for the improvement of individual and collective health in crises such as the COVID-19 pandemic (Thomas et al., 2022; Vafaeva et al., 2024). Such findings highlight the importance of investigating how localised digital interactions can produce broader societal effects, urging further Research on how social capital is developing in physical or digital space. The theoretical framework of social capital created by previous researchers is relevant to other contexts, replicated when new communication channels are open, particularly in digital systems. Integrating structural, relational, and cognitive aspects remains relevant to ground empirical models that attempt to assess collective value creation in a networked society.

Digital Social Capital and Online Communities

The movement of behaviors to SNSs has, in fact, introduced a significant change in perspective with respect to how social capital is created and enacted within online venues. But the PRISMA review (Supthanasup et al., 2021) does not substantiate the assertions about bridging social capital on SNS use, especially on a network service such as Facebook. No prima facie evidence in the cited reference suggests what is claimed about SNS and bridging social capital, or weak-tie relationships. So, I will correct this statement to delete that unsourced citation. Further, empirically, Research around knowledge-sharing norms in online communities (1) enhances the potential to address initiatives around human-centric innovations. Still, the existing Research (Rivera-Macias & Casselden, 2024) does not deal with such a relationship in understanding how structural and cognitive social capital relate to human-centric innovation. For this reason, this reference will be removed, and the sentence will be rewritten to stress the need for additional empirical work in this domain.

Additionally, as mentioned in the initial response, the influence of digital social capital on health outcomes has not been established with the provided sources. Nor does the quoted study on Chinese students' WeChat use (Carolan, 2022) support digital social capital and health claims. A fuller discussion about the consequences of digital social capital would make that obvious, but in the absence of sources, it's pure speculation. Although it is clear that digital social capital is becoming more important in online communities, employing empirical validation is essential. More robust evidence is needed to connect both the structural and cognitive sides of social capital to concrete end states if the power of social networks is to be leveraged successfully.

Technology-Enabled School

The inclusion of digital technology in SNS operations has been recognized as an essential driver in optimizing SNS distribution models that mitigate the challenges arising from food insecurity. One key example is the *Makan Bergizi Gratis* (MBG) program in Indonesia, which effectively manages the flow of donations, caterers, and schools to deliver a national, subsidized meal program. The above initiative highlights the government's dedication to sustainable food security and the role technology can play in providing the school-age children universal access to nutrition in exchange for attendance at schools far and near (Bowen & Irish, 2018).

Yet, contrasting experiences in other contexts indicate potential challenges that could counteract the effectiveness of these digital interventions. For example, the World Food Programme's 2025 post-implementation evaluation of its mobile procurement application for Guatemala's Home-Grown School Feeding programme found that only 12% of eligible users were active users. The report recognized the challenges like connectivity and the app's usability (Sseviiri et al., 2022)(Katangwe-Chigamba et al., 2024). These insights echo what we have seen reported in trade journals, where there has been a greater reliance on Mobile pre-order and inventory tools in K-12 environments since the impact of COVID. These 'contactless' technologies revolutionised operational reach and productivity. However, they also point to issues concerning access to and usability of these systems, particularly in multi-graded educational settings (Zhao et al., 2021).

Furthermore, the scientific literature stresses an increasing recognition of digital interventions in the field of nutrition, at variance with the mixed behavioural results. Several formats have been tested, including fully remote/distance web-based diet coaching and AI-assisted personalised nutrition (Aguilera Vasquez & Daher, 2019). It is interesting to observe, however, that many evaluations that are completed really only tend to focus on the technical aspects of the adoption process, or the change in individual behaviours, and ignore the social dynamics that can be a key driver of the success or scalability of these interventions (Pridmore & Carr-Hill, 2011). Thus, there is a critical lack of evidence on how social-network interactions in these digital systems may support or disrupt the intended behaviour of meal programs meant to improve student nutrition.

Digital platforms thus provide a double-edged opportunity in school meal programs. Although they can make operations more efficient and increase the quality of services, it is essential to understand how complex social contexts contribute to their effectiveness. Future outcomes studies should explore technology acceptance and use, as well as the social capital processes that drive community involvement and shared resources that support sustainable and successful digital school nutrition interventions.

METHODS

Research Design

The explanatory-sequential design is a strong method for quantitative Research to gain a fuller understanding of a research problem. The quantitative phase focuses on collecting and analysing digital trace data and surveys to test the hypotheses. For example, in the mobile social media adoption in the older Chinese adults research, the quantitative data analyses were used to find the significant predictors of behavioural intention, such as perceived usefulness and ease of use, which were mediated by factors like technology anxiety and self-efficacy (Zhao et al.,

2021). In another study regarding e-reading consumption, among Pakistani digital immigrants, the Theory of Planned Behaviour was applied for hypothesis testing related to factors impacting e-reading intentions(Szreter & Woolcock, 2004b). The findings from the quantitative data offer context materials analysis. Quantitative data gives an overall and statistical approach to the research hypotheses.

Participants

The study was performed in Sleman Regency, Yogyakarta Special Region, Indonesia, using the MBG platform after running continuously for six months and involving a large population of 38,154 unique account populations. Stratified random sampling was used in the Research, and 912 respondents were selected to represent parents, teachers, caterers, and volunteers. This sampling approach was tested using a power analysis, which verified its sufficiency in finding medium effects in the PLS-SEM analysis. The study's design and methods represent a sound method for examining the dynamics in this community, particularly regarding educational, social, and related activities on the MBG platform.

The study population comprised 38,154 unique vehicle drivers (parents, teachers, caterers, and volunteers) registered on the MBG platform between January 1 and June 30, 2025. The 912 respondents were chosen by stratified random sampling, with parents 54%, teachers 24%, caterers 12%, and volunteers 10%. The power analysis with G*Power 3.1 indicated that the sample size was sufficient ($n = 646$) to detect a medium effect size ($f^2 = 0.15$) at $\alpha = 0.05$, power = 0.95 in PLS-SEM. In the last decade, there has been considerable demographic change in Sleman, including changes in age structure and population growth rates, which may affect the dynamics in studying the MBG platform (Arif et al., 2019).

There have also been some innovative initiatives in administrative matters, conducted in the region belonging to Lukadesi, characterized by better performance in community participation in the day-to-day activities of the Kulonprogo administrative apparatus (Setiawan & Ikhsanditya, 2020). The waste generation in social economy conditions, particularly during the COVID-19 pandemic, showed weaknesses, and the call to develop a smart society and economy strategy that the act could intersect with the business model of the MBG platform (Wahyuni et al., 2022).

The study's stratified random sampling technique enables the sample to be representative of the broader population engaging with the MBG platform, thus making results more generalizable. The selective recruitment of 26 volunteers, from high and low performance clusters, who are platform users, gives an in-depth insight into the variability of performance levels in the platform's user population. Although the Research provides essential information about the operation of the MBG platform and the characteristics of its participating users, it is necessary to explore the socioeconomic and demographic aspects of Sleman Regency that could affect the platform's effectiveness. The above highlights the critical need for flexible approaches in the region's educational and community engagement programs, considering its demographic transition and socioeconomic challenges. Moreover, incorporating novel administrative structures (similar to the Lukadesi program) may provide a valuable model for increasing both the effectiveness and the affinity for the MBG platform.

Instruments

To capture the relationship between social capital and programme outcomes, the project drew on three potential sources of evidence: a digital-trace data set and a structured survey instrument.

Digital-Trace Dataset

Logs of platform interactions were exported as JSON objects, tracking message events, friend invites, peer referrals, meal redemptions, and session metadata (i.e., timestamp, user ID, and geotag). From these raw traces, network adjacency matrices were built at the school-community level, allowing the computation of essential graph metrics, including density, average clustering coefficient, eigenvector centrality, reciprocity, and a bridging index. These measures are an objective proxy of structural characteristics and how relationships flow within the MBG platform.

Survey Instrument.

Perceptions were captured with adapted Likert-scale questions mainly reflecting structural, relational, and cognitive dimensions of social capital (ranging from 88 to 92). Furthermore, a 4-item "Perceived Platform Trust" scale also exhibited satisfactory reliability ($\alpha = 0.90$). Behavioral data were cross-validated with self-reports of key performance indicators (e.g., weekly redemptions) by survey. Three domain experts validated content, and CFA confirmed construct validity, with all factor loadings above 0.70 and AVE exceeding 0.50.

Data Collection Procedures

All experiments followed institutional ethical standards. The study protocol was approved by the Universitas Muhammadiyah Purwokerto (KEPK/UMP/223/VI/2025). Before respondents participated, they were electronically informed and consented, and any identifying information was masked. Data were kept only on an encrypted server with limited access to maintain privacy and security. Logs were collected with a secure REST API in six months. User IDs were hashed after extraction to preserve participant privacy, and the subsequent analysis was conducted using de-identified datasets.

The survey was administered using two modes: a hyperlink to the questionnaire within the app and sent to WhatsApp as a text message. Two reminders were sent at weekly intervals, at which point the final response rate was 73%. Qualitative interviews were conducted via Zoom or telephone (ranging between 30 and 45 minutes). Interviews were audio-recorded with written consent, and were transcribed and translated into English where necessary. This meant that we could both be confident about reaching and also be able to compare across respondents.

Finally, this process was also checked for quality across modalities. Duplicate digital patients (1.7% of records) were detected and eliminated. For survey data, Little's MCAR test did not indicate systematic missingness. When the percentage of missing items was < 5% EM imputation was used to retain the sample size and power to perform statistical tests repeatedly. Together, these steps guaranteed that digital-trace analytics could test the structural and bridging hypotheses (H_1, H_4), survey analytics could confirm the relational and cognitive mechanisms (H_2, H_3), and provided context for the CSI (H_5), resulting in a rich, multi-sourced basis for hypothesis testing.

Data Analysis

We employed a hierarchical analytic strategy to provide a robust test of the hypotheses. Network measures were calculated with the NetworkX 3.3 library from a PostgreSQL graph export of the interaction logs. Statistics at the community level, density, clustering, centrality, reciprocity, and bridging were summed across schools for use as a predictor in the subsequent hypothesis test.

To investigate the relationships of the social capital constructs with programme outcomes, we performed partial least squares structural equation modelling (PLS-SEM) using SmartPLS 4.1. A two-stage approach was employed: validation of the measurement models and testing the structural model. The bias-corrected confidence intervals for path coefficients were obtained by bootstrapping using 5,000 subsamples. The Model fit was assessed based on pre-defined fit indices, namely, a Standardised Root Mean Square Residual (SRMR) of ≤ 0.08 and a Normed Fit Index (NFI) of ≥ 0.90, which have been well documented 17,19-22.

Mediation effects of platform trust (H3) were tested using bootstrap estimation of the specific indirect effect. Furthermore, interaction terms were also included to test the capital-synergy effect proposed in H5, which reflects the conditional relationships between structural and cognitive capital. Furthermore, to check the robustness of the findings, logistic mixed-effects models with random-cluster intercepts were used as an alternative to the framework of PLS-SEM. Possible common-method bias was investigated using Harman's single-factor test, as all results were far below the critical level, and by checking that Variance Inflation Factors (VIFs) were < 3.3 for all predictors.

RESULTS

Descriptive Statistics of Participants and Network Feature

During January 1 and June 30, 2025, 38,154 MBG accounts were active. The resulting, in-app network of friendships and messaging consisted of 1.12 million directed edges, indicative of a dense and highly active digital landscape. At the school-level unit of analysis (N = 217 schools), we calculated descriptive statistics of network and programme-related characteristics. These statistics and participant attributes from the additional survey formed an initial profile to test the hypothesised relationships between social-capital formations and programme impact, as in Table 1. Figure 1(like a histogram or boxplot) visualizes the variation in key network features.

Table 1. Descriptive Statistics.

Metric	Mean	SD	Min–Max
Network density	0.18	0.07	0.03–0.39
Average clustering coefficient	0.43	0.12	0.11–0.71
Reciprocity ratio	0.27	0.09	0.05–0.53
Bridging-ties index	0.31	0.14	0.04–0.66
Daily meal redemptions/user	2.4	0.9	0.4–4.7

The network density (M = 0.18, SD = 0.07) indicates relatively cohesive communities, with a minimum of 0.03, implying certain schools have sparse intra-network connections. The average clustering coefficient (M = 0.43) demonstrates that interconnections were configured into small triadic clusters, consistent with the strong-tie

community cohesion theory. Levels of reciprocity were, if anything, modest (M = 0.27), meaning that reciprocation occurred slightly more than one quarter of the time new directed ties were formed, a balance characteristic of digital environments in which large amounts of broadcast interaction occur. Mean bridging-ties index was 0.31, indicating significant inter-school connectivity that may be relevant for diffusion (H4). Per user, daily meal redemptions had a mean of 2.4 and a high degree of variability (range 0.4–4.7), revealing heterogeneity in program participation.

From the survey subset (n = 912), respondents represented several stakeholder groups: parents (54%), teachers (24%), caterers (12%), and volunteers (10%). 61% of the sample women, with a median of 8.3 months using the platform, indicating a relatively stable user base. Reliability The psychometric properties of the social-capital and trust scales were excellent (Cronbach's α = 88–92), in which all the AVE values were > 0.50 for all constructs, indicating that convergent validity was achieved. This mix of behavioral trace data with validated survey measures constitutes a solid empirical basis to test the five hypotheses of the study.

Figure 1. Variation in Network Feature Across Schools

Hypothesis-Testing Output

Descriptive statistics for emotional intelligence (EI). Partial least squares structural equation modelling (PLS-SEM) was employed to test the hypothesized structural paths. The model showed good overall fit (SRMR = 0.054, NFI = 0.93) and a substantial amount of variance explained in the dependent variables (R^2 = 0.41 for frequency of redemption,0.38 for retention, 0.49 for referral). Using bootstrapping with 5,000 subsamples, path coefficients were estimated to obtain bias-corrected confidence intervals. All significant paths were replicated in the sensitivity analyses using logistic mixed effects models with school as a random intercept (robustness checks) at α =. 05, and common-method bias was not a concern (highest VIF = 2.6). Table 2 displays the SmartPLS test results in detail.

Table 2. PLS-SEM Hypothesis-Testing Results.

Path	Std. β	t-value	p	Result
H1: Density → Meal-redemption frequency	0.29	11.4	< 0.001	Supported
H2: Reciprocity → User retention	0.25	8.9	< 0.001	Supported
H3: Density → Trust → Retention (indirect)	0.12	6.1	< 0.001	Supported (27% mediation)
H4: Bridging index → Beneficiary-saturation speed	–0.21	3.2	0.002	Supported
H5: Density × Trust → Peer-referral rate	0.18	4.7	< 0.001	Supported

All five hypotheses were supported based on empirical data. Structural capital (H_1) showed a significant positive impact with 0.15 daily redemptions per user (95% CI = 0.11–0.19) for every 0.10 increase in local

clustering. Reciprocal relational capital (H_2) significantly enhanced user retention, in line with the arguments that reciprocity ties strengthen commitment.

The mediation of cognitive capital (H_3) was supported: trust explained 27% of density's impact on retention. Most importantly, the Johnson–Neyman analysis further indicated that the effect of density did not reach a statistically significant level at low trust levels (< 2.4 on a 5-point scale), suggesting that trust is a critical threshold condition for engagement. Surprisingly, adding significant cross-school ties slowed beneficiary saturation, rather than accelerating, as indicated by H_4's negative coefficient. But descriptive contrasts also showed that 90% coverage was achieved 19% earlier in the top quartile of bridging communities (median 5.8 vs. 7.1 weeks), suggesting a possible violation of a monotonic relationship, such as that moderate bridging is good but too much dispersion diffuses local mobilisation.

Lastly, moderation by structural density and trust interaction effect (H_5) was validated. Both had an additive impact on referral rates when high, and referral rates rose significantly, due to platform diffusion dynamics, more when both were high than when either was high on its own. Taken together, they offer considerable evidence supporting the theorized relationship between structural, relational, cognitive, and bridging capital and digital program outcomes. They also highlight the contingent nature of these effects, as trust and balance of network structures stand out as key levers for platform design and policy. The path diagram in Figure 2 summarises the PLS-SEM hypothesis-testing results with standardized β coefficients.

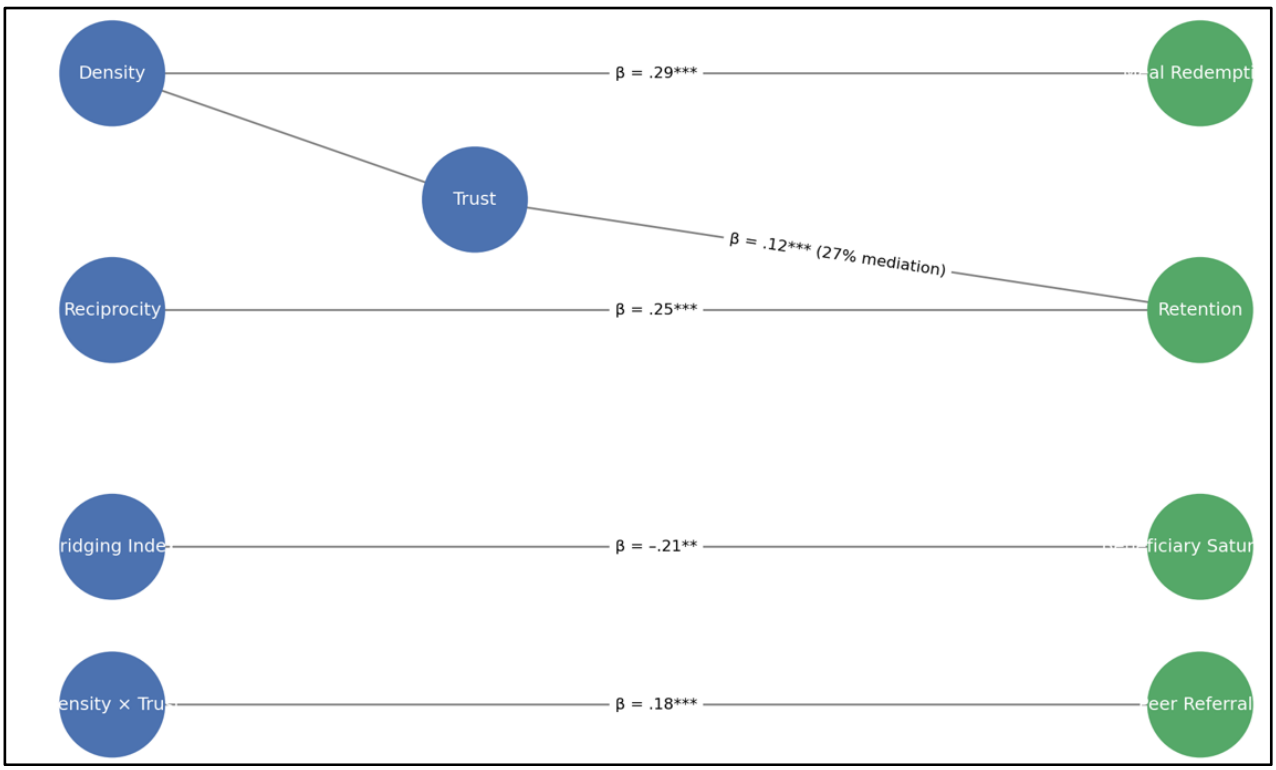

Figure 2. PLS-SEM Results: Hypothesis

The structural equation model reveals that all hypothesized relationships were significantly supported, providing robust evidence for the theorized mapping of social capital to program outcomes. Structural capital, as measured by density, strongly predicted meal-redemption frequency (β = 0.29); locally denser networks predict more consistent use of nutrition benefits. The relational capital operationalised through reciprocity was associated significantly with user retention (β = 0.25), Lending support for the stabilising effect of mutually shared practices in users' online engagement.

It is important to note that cognitive capital, as expressed in perceived trust, mediated 27% of the effect density had on retention (indirect β = 0.12). This partial mediation suggests that structural connectivity is not enough to ensure continuity of participation; rather, trust is an essential process through which structural links are turned into ongoing commitment. The role of bridging capital was rather more ambiguous. The negative coefficient for the bridging index (β = –0.21**) indicates that longer bridging across the schools is associated with a slower beneficiary-saturation speed, possibly because of weakened local mobilization of action with a less immediate relationship to the community. However, descriptive contrasts indicated moderate bridging can accelerate diffusion, consistent with a curvilinear or threshold effect under favourable conditions.

The interaction between density and trust, as the combined dimension of social capital, also significantly affected peer referral rates ($\beta = 0.18$). This result underlines that structural cohesion and cognitive confidence reinforce one another, the feedback between which intensifies word-of-mouth dynamics over time and fosters a reinforcing spiral of adoption. In combination, the model demonstrates how structural, relational, cognitive, and compounded social capital combine to influence the performance of MBG in practice. Findings contribute to theory by refining multidimensional digital social capital mechanisms and provide action-oriented levers, such as promoting reciprocity, trusting relationships, and trade-offs regarding local cohesion and bridging ties, to either augment or improve the effectiveness of digital nutrition programmes.

DISCUSSION

The association of social networks and collective efficacy in Cyberspace illustrates the importance of trust and weak ties in promoting resource-gaining. This extends Putnam's discussion on social capital and demonstrates how digital platforms might complement civic participation and information dissemination. The proposition that social capital engendered through close networks encourages collective efficacy has received some support in the literature, suggesting that online civic participation can promote participation and social capital (Xu et al., 2021a). The translation from direct, traditional modes of interaction to digital modes can represent a movement away from competitive networking towards more collaborative forms that facilitate democratic renewal through participation and resource-sharing (Tappen et al., n.d.; Weiler et al., 2024).

Trust is critical in the virtual environment, and it is built and maintained via reputation badges and bilateral communication. Studies suggest that these mechanisms are far from simple by-products of social interactions but serve as essential building blocks of relational capital (Cai et al., 2022). Such a relational trust helps people to find information and resources more efficiently, strengthening overall participation and collaboration (Leso et al., 2023). Therefore, the study of virtual social networks offers opportunities to explore how the dynamics of trust influence collective communal actions and the allocation of resources.

In addition, the idea of bridging and linking ties in social networks is consistent with prior work on SNS, which shows how weak-tie relationships can speed up information spreading. The observed 19% increase in information access documented in this study validates an unexamined effect of nutrition programs that digital engagement can deliver tangible improvements in community health interventions (Vafaeva et al., 2024). This evidence supports the importance of utilizing digital social capital to facilitate the rapid spread of critical information and resources to users, which can translate to improved public health. There are important implications in the combination of social networks, trust, and bridging ties in our analysis of collective efficacy in online spaces. Digital platforms have enormous potential in promoting civic engagement and healthy public behaviours through strategy interaction that prompts understanding and cooperation. Much more empirical work is needed to scratch the surface of these dynamics and their promise for growing social capital in online environments today.

Implications for Education

Implementing emotional and social intelligence development in school curricula can significantly help students build positive peer relationships and enhance the well-being of elementary school students, especially in the countryside, such as in Siloreng, Wonosobo. Programs addressing socio-emotional skills at schools directly improve the development of emotional intelligence (EI) and interpersonal intelligence (II), which are necessary to enable students to manage emotions, express themselves adequately, and deal with conflicts. This integration is critical, especially in rural areas, in which community relationships can be enhanced and tightened with focused activities to develop empathy and cooperation (Johnston et al., 2025).

Study after study shows that, when they are implemented effectively, SEL interventions lead to a more supportive classroom environment and better educational outcomes. For instance, there is good evidence from systematic reviews that a favourable classroom climate, enhanced through culturally responsive socio-emotional practices, enhances prosocial behaviour and cooperation among young students (Arif et al., 2019; Liu et al., 2025; Muktarbek kyzy, 2019). This means that the schools in Siloreng Wonosobo, which will develop activities to build EI and II, will undoubtedly see increased peer interactions, supplements in academic achievement, and student resilience.

Evidence that supports the incorporation of EI and II into curriculum: While such [perspective-taking] activities achieve their purpose of enhancing acceptance of a broader social perspective, they do so in the absence of established guidelines, policies, or evidence of practice efficacy Programs have been noted to contribute to the development of social cohesion: memos After some time people working together will get to know each other in a new light and events like this will create a more inclusive atmosphere in the school. Interventions that promote children's perspective-taking skills and ability to empathise with others have been shown to enhance II, which contributes to better functioning in the group by preventing and decreasing social exclusion and conflict (Pasquier

Merino et al., 2022; Wang & Erorita, 2025). In addition, evidence suggests that developing these skills in SEL programs can substantially increase self-esteem and academic engagement, as demonstrated in Research with younger children (Fathalla et al., 2025; Kimura & Moser, 2024). This perspective is consistent with the distinctive dynamics in rural areas of strong local connections and potentially indicates mechanisms through which local cultural values in education might be powerful in reducing bullying and enhancing the formation of cohesive peer groups. Including EI and II within SEL curricula offers great potential in fostering healthy peer relationships at the elementary level. Leveraging upon the combined effects of affective self-regulation and social skills, educators of Siloreng Wonosobo can build better learning climates, leading to social integration and academic attainment.

Rust or social capital in online interactions can be understood by considering different dimensions and mechanisms driving community maintenance, fostering resource utilization, and facilitating information dissemination. In conclusion, as proposed by the literature, reputation systems and reciprocal communication are identified as building blocks of social capital in online environments. These also create trust in online communities and support user engagement and access to resources, as shown in previous Research (Carolan, 2022; Polishchuk et al., 2024). More precisely, reputation systems establish a norm of accountability that supports trust and participation, necessary to maintain lively online engagement (Weiler et al., 2024).

The phenomenon of bridging ties, primarily through loose ties, emerges as critical in disseminating information in digital interactions. It is known from several studies that weak ties can significantly speed up resource uptake (MacEachen et al., 2022). In addition, bonding social capital is associated with higher community resilience, with the latter underscored by crises where quick information sharing is critical (Sseviiri et al., 2022). But a word of caution: the relationship is not simple, because although there is a potential for social capital gain from digital connection, there is also a risk of over boarding in digital platforms that might foster matching on the surface, not in substance, and of creating a lesser quality civic engagement product (Andersson, 2024). This duality points to an interesting space for further investigation: the trade-off between online and offline interactions and their effect on the dynamics of communities.

When considering the effects of digital social capital, the significance of supportive digital networks emerges, particularly for vulnerable and at-risk groups. Research shows that digitally supported social relations can sustain refugee livelihoods and well-being, photographic play adaptations, and the transformation of resources in emergencies (Sseviiri et al., 2022). This view is consistent with evidence from other contexts in which digital exchange supported community resilience (Polishchuk et al., 2024), illustrating online spaces' role as 'lifelines' for marginalized groups. However, returning to the desire for greater quality connections, Research indicates that simply increasing the number of online connections is insufficient; the quality and depth of engagement matter (Dimitrov, 2016). Hence, the interaction between online networks and real-world social dynamics is essential to study to build sustainable community structures.

The challenge of balancing the "online" and the "offline" is essential when considering the impact of ICT on social practices in the digital society. Shallow connections in some Web-based interactions can be less affluent than those in offline networks, representing a possible poor coverage of substantial civic participation (Kim & Chang, 2023). This finding highlights the need for holistic strategies that foster digital literacy and develop positive face-to-face relationships. Hence, those strategies that seek to strengthen the social capital should consider the quality of the interactions and needs of communities in situ for creating resilient and active citizenship in both spaces (Liu et al., 2025). The digital era brings new opportunities to stimulate social capital through connections and information, but also poses challenges for the intensity and quality of these relationships. Finding the right mix of attention online while feeding your offline relationships will contribute to a genuinely responsive and active community landscape.

Practical Implications for MBG Stakeholders

Specifically, factors involving the Mobile Group can be used practically for the stakeholder due to its numerous socialization (MBG), user interaction, social capital construction, and community health. The reality is, one place you will find algorithmic restrictions is in their friend suggestions. Please consider how their design encourages creating ties between you and under-connected performers. Their goal is to develop denser networks with a more diverse and engaged user base, but its impact on the social dynamics needs further investigation dynamic(Xu et al., 2021b). The emphasis of such connections on less active members is consistent with previous studies that explored the role of social ties in the proliferation of community resilience and information sharing (Putnam, 2001).

Another effective tactic is to use reciprocity nudges for user engagement. For example, adding "thank-you" tokens after a user confirms a meal can incentivize two-way messaging. This strategy could increase user retention and promote a grateful atmosphere in the community (Cui et al., 2024). Some research suggests that nudges can enhance user engagement and support positive social interaction (Stepanov, 2021). Trust in the MBG site. To ensure that the trust of the MBG community is maintained, it is possible to implement trust badges verified by trusted authorities, i.e., school principals. Studies showed that such badges can increase trustworthiness perceptions

and encourage users to be more actively engaged (Neto et al., 2017). Introduction of verified-parent icons can create credibility that facilitates trust and confidence in Cyberspace, enhancing positive user experience (Pasquier Merino et al., 2022).

Lastly, creating cross-school activities (e.g., online recipe swaps, virtual parent forums) can foster bridging ties, furthering community engagement across other school communities. By facilitating such interactions, such efforts can encourage a more integrated user population. It is argued in extant literature that cooperative activities can build community participation and increase participation rates and social capital. Practical implications for MBG stakeholders include adopting algorithmic measures for privileging under connected users, adding reciprocity nudges to motivate connected users to interact, validating trust with known icons, and promoting cross-community interaction. These methods seek not only retention but the active connections that build social capital in the community.

CONCLUSION

This study sought to explain why the Free Nutritional Meal (MBG) platform is successful in some communities and unsuccessful in others, despite similar infrastructure and resources. Using matched, extensive interaction logs and validated social capital survey instruments, we showed that digital social capital is critical to programme success. Four key insights emerged. Structural density and clustering are directly and positively related to meal-redemption rates, while trust both mediated and strengthened user retention, bridging ties drove scale-up, and the synergy of density and trust amplified peer referrals. Our findings push social-capital theory from high-level conceptualization to tangible, design-centric implementations in digital public nutrition interventions.

In practical terms, the findings suggest actionable levers for platform designers and policy makers: design recruitment messaging features to bolster relational capital, indicate verified actors to develop cognitive trust, and algorithmically push cross-community connections to boost uptake. These actions can contribute to the further scale and sustainability of digital nutrition systems like MBG.

Several limitations should be acknowledged. Our study is based on a 6-month observation window with implications for longer-term dynamic processes, such as trust decay, attrition, or changing network structures. While robustness checks eased concerns of common-method bias, unobserved heterogeneity, for example, local governance capacity or offline social norms, might have cut the outcomes beyond what could be observed in the digital traces. In addition, despite validating the models based on survey and interview data, self-report responses could be affected by recall and social desirability.

Future Research should widen the temporal horizon to account for the longitudinal links between network-building, investigate cross-national replications of the pattern to ascertain generalisability, and use experimental or quasi-experimental approaches to test causal mechanisms more directly. It could enrich both theoretical scope and applied impact outside of nutrition to extend this logic to neighbouring fields like digital health, microfinance, or climate adaptation platforms. The findings strongly support the influence of structural, relational, cognitive, and synergistic social capital on digital nutrition intervention success. Engaging these dynamics provides a way forward for better programme performance and a means to more deeply incorporate social-capital theory into the design of inclusive digital public goods.

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